Update on Latest Changes to Vapor Intrusion Sections of the SAM Manual

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Earlier Efforts

- The current Vapor Intrusion (VI) Technical Work Group (TWG) began in February 2004. The original scope of work included
  - Update to the SAM manual
    - Alignment of agency guidelines (USEPA, DTSC & SAM)
    - Establishing guidance on collection of fixed gases
    - Developing vertical profiling protocol
    - Incorporating sub-slab sampling
    - Spatial averaging
    - Determining complete vs. incomplete pathways
    - Chemical properties (Petroleum vs. Chlorinated)
  - Updating vapor risk model to be aligned with DTSC and EPA

Earlier Efforts

- Delays & Revised Scope:
  - In 2010 due to:
    - delays in finalizing DTSC December 2004 Vapor Intrusion Guidance, and
    - the significant activities at the Federal level related to Vapor Intrusion
  - The new TWG defined its scope to edit the SAM Manual by:
    - including the Draft DTSC Guidance by reference, and
    - updating procedures to make current until final guidance is provided at the State and Federal Level.

Most recent VI TWG was re-established in 2010 and ended work in early 2011.

- Members:
  - Kevin Heaton
  - Sam Williams
  - Blayne Hartman
  - Todd Ririe
  - Doug Roff
- Updated portions of Sections 5 & 6 and Appendix F

Once DTSC finalizes their December 2004 Vapor Intrusion Guidance and the issues being discussed at the federal level have been addressed, further changes will need to be made. This may be within the next couple of years.

Areas modified in Section 5

IV. SOIL VAPOR SAMPLING – Field Data Collection

The SAM Manual does not provide guidance on indoor air sampling. Readers are referred to:

- DTSC vapor intrusion guidance, and
- ITRC vapor intrusion guidance (www.itrcweb.org).

Overview of Soil Vapor Survey Methods

Section was modified to allow the use of Passive methods for qualitative and quantitative applications for <u>assessment purposes only</u>.

- Quantitative applications: *The uptake rate must been experimentally measured and reported* in a scientific publication.
- Qualitative applications: Qualitative applications are useful for delineation, but will generally require verification prior to use in estimating exposure point concentrations.
- The *use of passive sampling data for risk assessment purposes should be pre-approved* by DEH."

Active Soil Gas Surveys

There is a new section on probe installation including method and materials.

Probe Installation

- Pre installation activities to locate potential subsurface structures of features such as buried pipes, tanks and electrical lines.
- Two techniques are most commonly used to install soil gas probes:
- Insertion of a hard rod (probe) to a target depth, collection of soil gas through the rod while it is in the ground and subsequent removal of the rod.
- Burial of an inert pipe or tube (typically 1/8" to ¼" OD) to a target depth with subsequent sampling of the soil gas. Tubing can be buried in holes created with hand driven rods, direct-push systems, hand-augers, or drill rigs.


50ml
40
30
20

Active Soil Gas Surveys (continued)

Update on collection depths.

Collection Depth

- Depths should be chosen to maximize the chances of detecting contamination
- Depths should minimize the effects due to vapor movement, barometric pressure, and surface temperature, or breakthrough of atmospheric air from the surface
- The effects due to these processes are considered to be minimized at depths 3 to 5 feet bgs.
- Soil gas data from depths less than 3 feet bgs or below the foundation are collected, additional sampling events may be appropriate.

Active Soil Gas Surveys (Continued)

Update on purge volumes.

- For active soil vapor sampling the purge volume primarily includes only the internal volume that is filled with air or some other inert gas prior to insertion into the ground.

- This internal volume, often called the dead volume, must be completely purged.

Active Soil Gas Surveys (continued)

New section on probe sampling flow rates and applied vacuums.

Sample Flow Rate – The primarily concern is that excessive flow might create turbulent flow at the probe tip and influence the soil-gas concentrations.

- DTSC have put a limit on sample flow rate (typically <200 mL/min)
- USEPA in studies have measured soil-gas concentrations over different flow rates ranging from 100 mL/min to 5000 mL/min in soil gas probes in course-grained soils. Results showed no significant differences in results.

Active Soil Gas Surveys (continued)

New section on probe sampling flow rates and applied vacuums (continued).

Applied Vacuum – Higher vacuums increase the potential for leaks in the sampling system and for potential desorption of COCs off the soil.

- DTSC are requiring applied vacuums at the probe to be less than 10 inches of mercury.
- A qualitative field test method can be used to estimate if there is low permeability soils will result in much vacuum is likely.
- This method consists of applying a 20cc to 50cc gas-tight, plastic syringe to the probe and pull on the plunger. If the plunger is hard to pull (compared to pulling outside air) or if the plunger is pulled back towards the probe after released, then there is likely too little permeability to get an uncompromised sample.

Active Soil Gas Surveys (continued)

New section on equilibrium times before purging and sampling.

- When probes are installed, the in-situ soil gas can be displaced and a period of time is required for the soil gas to re-equilibrate.
- A recent USEPA study showed the following equilibration times were required:
  - Sampling through probe rod installed by hand: 30 minutes
  - Sampling through probe rod installed with direct push methods: 1 hour
  - For probes where tubes are buried in a sand pack in the ground: 8 hours

Active Soil Gas Surveys (continued)

New section on testing for leaks.

Testing for Leaks is to ensure that valid soil gas samples are collected with no breakthrough of air down the probe rod or through leaks in the sampling train. Tracer compound(s) can be applied at the base of the probe rod or at the top of the buried probe tubing where it contacts the surface and near all connections in the sampling train.

Common tracer compounds are:

- gases (e.g., helium, carbon dioxide, SF6, butane) or
- liquids (e.g., Freons, isopropanol, hexane).

If the tracer compound concentration in the soil gas sample is less than 15% of the concentration of the tracer compound measured in the shroud, then the sample is considered leak-free

Active Soil Gas Surveys (continued)

Update on sample containers and storage of samples.

Sample Containers – Summa Canisters:

- Canisters generally are large volume containers (1 to 6 liters) under high vacuum,
- Extra care should be exercised during sample collection to ensure that air from the:
  - surface is not being inadvertently sampled or
  - desorption of contaminants from the soil does not take place.
- To minimize the potential of surface breakthrough, seals around the probe rod at the surface should exist.
- To minimize the potential desorption of contaminants from the soil, Summa Canisters should between 500 to 1000 mL in size and should be filled at a rate less than 200 mL/min.


SAMPLE ID
DATE
TIME
H&P

Passive Soil Vapor Surveys

Minor updates

- Renamed section titled *Transient and Other Environmental Effects* to *Temporal Variation and Other Environmental Effects*
- Removed the section on the effects of earth tides.

Soil Vapor Surveys Design

Petroleum Related Sites

Because petroleum products, such as gasoline and diesel, are complex mixtures containing a wide variety of different hydrocarbons, the appropriate analytical measurements depend upon the product type as follows:

- Aromatics (BTEX) and naphthalene: Method 8260, TO-15, or TO-17.
- MTBE and Oxygenates: Method 8260, TO-15, or TO-17
- Methane: The use of gas chromatography method with a flame detector, such as 8015 modified.
- Carbon Dioxide, Oxygen and Nitrogen: The use of gas chromatography (GC) method with a thermal conductivity detector, such as ASTM Method 1945-96. Portable GC meters, if calibrated correctly on day of use, are also allowed for these compounds.
- PAHs: Due to low vapor pressures, these compounds cannot be detected by active soil gas methods (except for naphthalene) and only the lightest ones can be detected by passive soil gas methods.

Soil Vapor Surveys Design (continued)

Petroleum Related Sites (continued)

- Site Assessment/Characterization Applications – Only editorial changes were made.
- Health Risk Assessment Program Design – Sampling frequency was modified to indicate that, one to two sampling events, following probe installation, is generally sufficient to assess the risk pathway

Soil Vapor Surveys Design (Continued)

Dry Cleaners & Industrial Facilities with Non-Petroleum VOCs

- Moved Vapor Clouds discussion to beginning of the section
- Moved Potential Impacts of Vapor Contamination on Groundwater discussion to beginning of section (Page 5-26 to 5-27)
- Not all compounds at a facility may be detectable by soil vapor methods depending upon their vapor pressures.
- For quantitative programs, the appropriate analytical methods are 8021, 8260, TO-15, or TO-17.
- The detection limits, calibration procedures, and other QA/QC criteria should meet the requirements presented in Section 5.IV.B.

Laboratory Analysis of Soil Gas Samples

- Renamed section titled *Detection Limits (DL)* to Reporting *Limits (RL)*
- Removed section on Detectors and replaced it with a section titled Analytical Methods.
- Initial Calibration was changed to have the standard curve to be defined using five concentration standards instead if three standards.
- Revised acceptable RSD and LCS values.
- Removed section titled *On-site Evaluation Check Sample*.
- Renamed section *Record Keeping in the Mobile Laboratory* to *Record Keeping in the Laboratory*.
- Reporting of Soil Gas Samples Results and QA/QC Data was modified.

TABLE 5-11: PREPARATION METHODS

SUSPECTED SUBSTANCE	TPH METHOD
Gasoline, Diesel, Jet A Fuel, Kerosene	EPA 8015B or DHS-LUFT using a solvent extraction and EPA 5030 purge
Gasoline only	EPA 5030 using purge and trap followed by GC/MS
Diesel only	EPA 8015B using a solvent extraction
Lead	EPA 3050/6010
Stoddard Solvent	EPA 8015B using a solvent extraction

TABLE 5-12: REPORTING LIMITS

Contaminant & Method	Matrix	Recommended Reporting Limit
Gasoline, Diesel, Jet A Fuel (EPA 8015B)	Soil	Gasoline & Jet A -10.0 mg/kg, Diesel 500 mg/kg
	Water	Gasoline & Jet A - 10 ug/l, Diesel 500 ug/l
	Vapor	NA
Benzene (EPA 8260)	Soil	0.05 mg/kg
	Water	0.5 ug/l
	Vapor	0.1 ug/l-vapor
Toluene (EPA 8260)	Soil	0.05 mg/kg
	Water	0.5 ug/l
	Vapor	1 ug/l-vapor
Xylene (EPA 8260)	Soil	0.05 mg/kg per isomer
		0.15 mg/kg isomer total
	Water	0.5 ug/l per isomer
		1.5 ug/l isomer total
	Vapor	1 ug/l-vapor
Ethylbenzene (EPA 8260)	Soil	0.05 mg/kg
	Water	0.5 ug/l
	Vapor	1 ug/l-vapor
Volatile Organic Compounds (EPA 8021 or 8260)	Soil	0.005 mg/kg to 0.5 mg/kg depending on compound
	Water	0.5 ug/l to 100 ug/l depending on compound
	Vapor	1 ug/l-vapor
Organic Lead (EPA 6010 or 3050)	Soil	0.5 mg/kg

TABLE 5-12: REPORTING LIMITS (Continued)		
Contaminant & Method	**Matrix**	**Recommended Reporting Limit**
Total Lead (EPA 6010 or 6020)	Water	5 ug/l (primary MCL for drinking water)
Total Recoverable Petroleum Hydrocarbons (EPA 418.1)	Soil	10.0 mg/kg
	Water	500 ug/l
MTBE, TAME, DIPE and ETBE (EPA 8260B)	Soil	0.1 mg/kg
	Water	1 ug/l
	Vapor	1 ug/l-vapor
TBA (EPA 8260B)	Soil	1 mg/kg
	Water	10 ug/l
	Vapor	10 ug/l-vapor
PNA/Naphthalene (EPA 8270 or 8260) and PNA (EPA 8270 or 8310)	Soil	200-400 ug/kg
	Water	10 ug/l
	Vapor	Site specific. Check with DEH representative.
PCBs/Pesticides (EPA 8082 or 8270)	Soil	SW-846 requirements/estimated quantitation limits
	Water	
Vinyl chloride	Soil	0.005 mg/kg
	Water	0.5 ug/l
	Vapor	0.05 ug/l-vapor.
Methane (EPA 8015 Mod)	Vapor	10 ppmv (0.001%)
Carbon Dioxide (CO_2) – Field Method	Water	Check with DEH representative.
	Vapor	1000 ppmv
Oxygen (O_2)	Water	Check with DEH representative.
	Vapor	1000 ppmv
Nitrogen (N)	Vapor	10000 ppmv

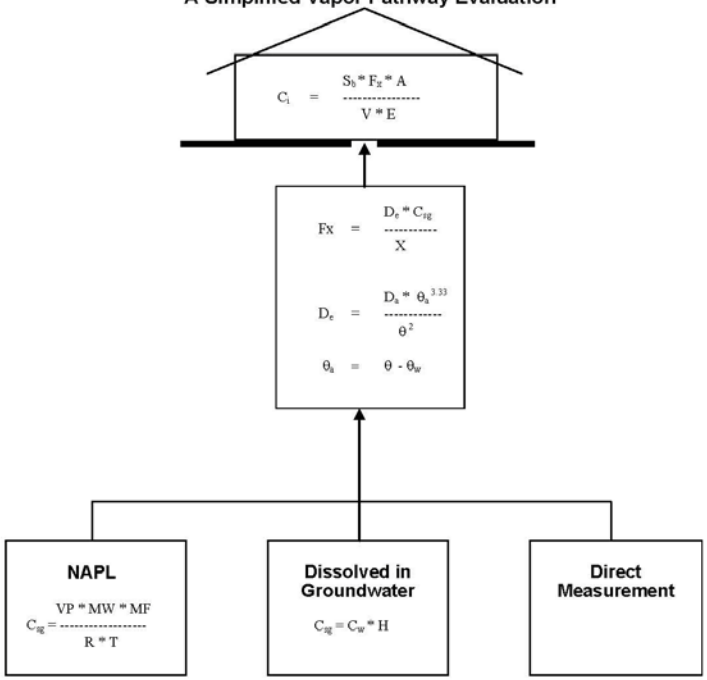
Areas modified in Section 6

- Removed the option of calculating risk using soil data.
- Minor editing changes

Areas modified in Appendix F

- Updated the Level 1 example to describe a site with residual petroleum free-product near a residence and
- Updated the Level 2 example to describe a release from a dry cleaning business

FIGURE 6-2
A Simplified Vapor Pathway Evaluation



A	=	the room floor area (m^2)
C_{sg}	=	the contaminant concentration in the soil vapor (mg/m^3)
C_w	=	the concentration in pore water (ug/l)
C_i	=	the indoor air concentration (mg/m^3)
D_a	=	the diffusion coefficient of compound in air (cm^2/sec)
D_e	=	the effective air diffusion coefficient (cm^2/sec)
E	=	the indoor air exchange rate per hour (hr^{-1})
F_g	=	the contaminant vapor flux ($mg/hr\text{-}m^2$)
H	=	the Henry's law constant (dimensionless)
MF	=	the mole fraction (dimensionless)
MW	=	the molecular weight of the compound of concern (mg/mole)
R	=	the universal gas constant ($atm\text{-}m^3/mole\text{-}K$)
T	=	the temperature in degrees Kelvin (°K)
S_b	=	the slab attenuation factor (dimensionless)
V	=	the room volume (m^3)
VP	=	the contaminant vapor pressure at STP (atm)
X	=	the depth or distance to contamination in the vadose zone (m)
θ	=	the total soil porosity (dimensionless)
θ_a	=	the air filled porosity (dimensionless)
θ_w	=	the water filled porosity (dimensionless)
ρ_b	=	the dry bulk density of soil (gm/cm^3)

- Questions?